

Promoting School-Based Hearing Screenings Among Hawaii's Youth

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Abstract

The hearing of a child can often be taken for granted. Hearing is not only important in day-to-day communication, but is vital in the overall development of infants and children. Although hearing loss is generally associated with aging, concerns for hearing conditions can start as early as birth. Having the ability to hear is critical in speech and language development, communication, and learning in children. Considering the difficulty in recognizing hearing impairments among youth, it is vital to provide accessible complete hearing screenings to school-aged children. To address this need, the Hawai‘i Lions Club (HLC) has created a statewide hearing screening program that is implemented in Hawai‘i Department of Education (HDOE) schools. By providing hearing screening for students primarily in kindergarten to the third grade, the goal of the screening initiative is to achieve early identification of hearing loss or any ear-related concern.

This project was designed to increase awareness of the HLC’s hearing initiatives and to compare descriptive and outcomes data from the program between the 2015-2016 academic year and 1995, when the last comprehensive report was completed. A total of 5,937 students were screened throughout the 2015-2016 academic year. The project utilized a 1995 hearing screening initiative conducted by the Hawai‘i Department of Health (HDOH) as a benchmark with which to compare HLC’s current hearing screening initiative. Recommendations include expansion of screenings to more HDOE schools, recruiting more volunteers to aid in statewide screening, and completion of an updated comprehensive report by the HDOH.

Keywords: School-based hearing screening, hearing loss, pediatrics

Table of Contents

Abstract	i
Chapter One: Significance	1
Chapter Two: Introduction	5
Chapter Three: Methods	13
Chapter Four: Results	17
Chapter Five: Conclusion	22
Bibliography	27

Significance

Being one of the first states to implement a hearing program for newborns, Hawai'i has been viewed as a leader in diagnosing congenital hearing loss at birth. This newborn hearing program requires all newborn infants born in the state to be screened for hearing impairment for early identification of hearing loss within one week of birth. Hearing is a critical factor in the development of children, as a strong positive association exists between a child's early development and hearing. According to the Hawai'i Department of Health, three to six infants per every one thousand are diagnosed with some type of permanent hearing loss. In addition, fifty to sixty toddlers are diagnosed with hearing loss each year in Hawaii (Hawaii State Department of Health, 2013). Although the state efficiently operates a hearing screening program for newborns, there is currently no program sponsored by the state that provides follow-up hearing evaluations after the initial newborn hearing screening. Although this at-birth screening is crucial, an infant that passes the newborn test is still susceptible to contracting hearing impairments in the future. In order to prevent the negative impacts that are associated with the onset of hearing impairments, it is critical to implement a long-term hearing-screening program to maintain hearing health among Hawai'i's youth beyond the newborn hearing screening program.

In a study conducted by Prieve et al. (2015), the need of implementing school-based hearing screenings was emphasized through the analysis of the negative impacts hearing impairments can have on one's academic success and social development. It had been found that it is crucial to have follow-up hearing screening in schools as the prevalence of hearing loss in school-aged children are at least double compared to newborns (Prieve et al., 2015). The study

also included the negative impacts associated with all degrees of hearing impairments among school-aged children. The most outstanding of these impacts are the negative effects hearing loss has on the educational performance of a child. Considering how heavily the United States education system depends on auditory information, a student with hearing loss can often be left behind. Speech signals sent in a classroom setting were found to be degraded by a combination of background noise and echoing, which can drastically hinder the speech perception ability of a student with hearing loss (Prieve et al., 2015). To accurately compare the academic differences between elementary students with hearing loss to those with normal hearing, Antia et al. compared and contrasted standardized test scores throughout a five year timeline. The study found students with hearing loss earned scores half a standard deviation below the average score earned by students with normal hearing (Antia, Jones, Reed, & Kreimeyer, 2009). In addition to lower test scores, elementary children with hearing loss were also found to experience greater fatigue and lower self confidence when compared to their peers (Bess et al., 1998). In order to lessen the negative impacts hearing impairments can have on academic and social development, students with hearing impairments should be identified as early as possible.

By providing access to school-based hearing screenings, children who were not able to receive a hearing test at birth along with those who do not have a primary doctor are given the opportunity to receive a full audiology examination. Through implementation of school-based hearing initiative in Hawai'i schools, obstacles concerning accessibility and affordability are essentially eliminated. One of the strengths of conducting hearing screenings among school-aged children is the ability to identify individuals who may have delayed onset hearing loss. Even if a child passes the newborn hearing screening done at birth, there is a possibility for a late onset of hearing loss to occur in the child. To validate this need of testing, a group of researchers in China

conducted a hearing evaluation to be done on children who had already completed and passed their newborn hearing screening. The study consisted of 28,456 participants between ages 4 to 5 that received the same hearing examination as was given to the children at birth (Chen et al, 2013). From this study, 540 children (1.89%) did not pass the audiological evaluation and were sent to an audiologist for further testing. From the 540 referrals, 342 students were diagnosed with conductive hearing loss, which is usually considered as a temporary ear condition. 22 children out of the group referred were diagnosed with either unilateral or bilateral permanent hearing loss. The remaining students of the 540 referred (173 cases) resulted in having normal hearing and did not require further treatment or assessment. The detection of permanent hearing loss in students screened was found to be 0.77 students for every 1,000 students screened in the 3-6 year old children who have already passed the newborn screening program at birth (Chen et al, 2013). Because neonatal hearing screenings do not have the ability to identify delayed-onset of hearing loss, a program dedicated to follow-up with post-natal care is needed. The findings from the study conducted by Chen et al., suggests the importance school-based hearing screening play in the identification of delayed-onset hearing loss in preschool students in China (Chen et al., 2013).

A study conducted by Watkin & Baldwin found similar results in school-based screenings. Watkin and Baldwin conducted a study where children who had already passed the newborn hearing screening at birth were retested at age six. The study consisted of 35,668 six year old children where a follow-up hearing examination was conducted. The reason for this study was to determine the number of students with a delayed onset of hearing loss, which is a case that is not detectable by the newborn hearing screening. The study found 4 out of the 1,000 children screened had permanent hearing loss (Watkins and Baldwin, 2012). Out of the

individuals identified with moderate to severe hearing loss, the study found that only 1 out of 1,000 screened would have been identified by the newborn hearing screening. From the children found to have permanent hearing loss in this screening, less than 60% would have been identified solely from the newborn hearing screening (Watkins and Baldwin, 2012).

In order to promote long-term hearing and ear health, it is vital for the state to have an established and supported program that provides school-based hearing screenings in Hawai'i schools. Considering the negative impacts associated with hearing loss, early diagnosis is key in limited the impact these effects have on the children. Through the identification of hearing impaired students at an early age, students are able to experience the maximum benefits of treatment and intervention in response to the individual's hearing loss. Because of the possibility of a delayed onset of hearing loss after a child is screened through the universal newborn hearing screening, it is important to have accessible post-natal screenings such as school-based hearing screenings readily available. With the implementation of a well supported and staffed school-based hearing screening program, children will be allowed to not only have access to healthy ear health but also a overall better quality of life.

Introduction

In today's society, it is extremely common to find one's ability to hear taken for granted. Whether it is a student listening to lectures, a waiter taking orders, or an individual relaxing to the sound of music, all people rely on their ears. The term "deaf" can be defined as a, "Lacking, or defective in, the sense of hearing" (OED Online, 2013). Although hearing impairments are usually associated with aging, hearing loss is also prevalent in populations of newborns and children. In fact, an estimated 1.2 million to 1.5 million school-aged children in the U.S suffer from hearing impairments (Pediatric Child Health, 2008). Serving as an essential factor during a child's development, it is vital to diagnose any hearing loss in children as early as possible. Early detection of hearing impairments in youth is key in preventing and minimizing the onset of hearing-related issues. By identifying affected individuals in a early manner, more time is allowed in the treatment and intervention process, ultimately allowing for the least possible amount of detrimental effects caused by hearing loss. In order to successfully protect Hawai'i's future generation from hearing impairments, proactive hearing screenings must be implemented and continued throughout the developmental stages of Hawaii's youth.

Hearing Loss in Infants

Throughout an infant's developmental stage, the ability to hear plays a vital role in speech, behavior, and psychological growth (Hearing Loss in Children, 2012). In the viewpoint of many pediatricians and health care providers, it is critical to take a proactive and preventive approach towards deafness in youth. Having an incidence of 1.4 per every 1,000 births, congenital hearing loss is the most common neonatal sensory disorder in the United States (CDC, 2011). Having strong associations with delays in speech-language skills and cognitive

development, cases of neonatal hearing loss are immediately transferred to early intervention programs. Ranging from speech therapy to hearing aids and even surgically implanted devices, early intervention programs aim to start services before one month from diagnosis. In a study conducted by Dr. Yoshinaga-Itano, an improvement of forty percentile points in speech and cognitive development was observed in a group of children who received early intervention no later than six months of diagnosis (Yoshinaga-Itano, 2004). The importance of hearing screenings for newborns is recognized throughout the world and is supported by organizations such as the National Institutes of Health, Joint Committee on Infant Hearing, and the American Academy of Pediatrics (Yoshinaga-Itano, 2004). The US Preventative Services Task Force (USPSTF) had found that since the implementation of the universal newborn hearing screening program, the average time needed for an infant to be diagnosed with hearing loss dropped from 12-13 months to about 3-6 months (Yoshinaga-Itano, 2004). With the diagnosis time having been cut in half since the implementation of the universal newborn hearing screening, there is a higher possibility for intervention such as hearing aids to be provided at a faster rate. From a data analysis done in Colorado by USPSTF, the implementation of the universal newborn hearing screening program had reduced the time it took for a an infant to receive hearing aids from 13-16 months to five weeks of age (Yoshinaga-Itano, 2004). The implementation of the newborn hearing screening resulted in an incredible decrease in time needed for diagnosing and treating infants with congenital hearing loss that is present at birth.

Hearing Loss in School-Aged Children

As the universal newborn hearing screening policy grows more popular, resources and research have focuses on hearing impairments that entail a loss of more than 40 decibels (Wake et al., 2004). Although losses of this sort are important to recognize, these conditions are not as prevalent and widespread as conditions that typically arise in school-aged children (Wake et al., 2004). According to Bess et al., children who have been diagnosed with “minimal sensorineural loss” are linked to low early academic performance and high rates of grade repetition. In addition, as students progressed through school, those with hearing loss reported having lower functional health when compared to their peers with normal hearing through the use of the COOP Adolescent Chart (Bess, 1998). In adults, it is known that mild to moderate hearing loss is linked to lower verbal memory performance. A study by R.C. Beattie found that background noise is especially disruptive for adults with mild to moderate hearing loss, causing substantial difficulties in day-to-day life (Beattie, 1997). However, there is no study conducted that explored the possible detriments mild to moderate hearing loss can bring to a child in regards to everyday living and behavior.

Delayed Onset of Hearing Loss

Delayed onset of hearing loss is the phenomenon where hearing loss is developed in an individual over time. A young child may have healthy hearing during his/her first 2 or 3 years and begin to lose hearing thereafter (Malsam-Rysdon, 2012). Although there are some key risk factors related to the cause of a delayed onset of hearing loss, researchers and health professionals do not entirely understand the reasoning behind this. To explore the reasoning

behind delayed onset hearing loss cases, Kraft et al., conducted a study of 25,440 infants who went through the universal newborn hearing screening in the hospital. The initial hearing screening referred 940 infants, which equates to a rate of 3.7%. Out of the referred infants, 567 (60%) followed-up with the recommended follow-up testing. Permanent hearing loss was found in 90 infants, which includes 16 infants with delayed-onset hearing loss. The prevalence found for an infant with some type of hearing loss is 3.4 per 1,000 infants screened. (Kraft et al, 2014). To further investigate possible causes to explain the 16 infants diagnosed with delayed-onset hearing loss, the study conducted simple logistic regressions to estimate the odds ratio of hearing loss for each risk factor studied. Despite common belief in risk factors associated with delayed-onset hearing loss, the study found that a NICU stay of greater than five days was not associated with any type of hearing loss in the 16 infants studied (Kraft et al, 2014). The study did find an increased rate of delayed-onset hearing loss for infants in the study who was affected by hyperbilirubinemia, in utero infections, syndromic conditions, and meningitis

How Hearing Is Tested

In the case of testing hearing in newborns, physiologic-based testing methods are preferred over standard behavioral response-based testing. Tests performed on infants do not require any voluntary responses as testing results are based on the body's physiologic response. As for what is being tested, healthcare professionals usually focus on the function of the infant's middle ear, inner ear, and hearing nerves. The middle ear is vital in the travel of sound through the ear canal, which can often be affected by the presence of excess earwax or fluid. The main function of the middle ear is to transform incoming sound waves into mechanical piston-like energy that is able to stimulate the inner ear (Venema, 2014). To test the middle ear's function,

many healthcare professionals choose to conduct tympanogram testing. This test includes the insertion of a probe tip that essentially changes the air pressure in the patient's middle ear. By changing the ear canal's pressure, the test is measuring the eardrum's ability to move back-and-forth. If patients fail the tympanogram test, it is likely that the eardrum is not moving as it should be and is often associated with a build of fluid in the middle ear.

Besides the middle ear, another area of interest to a healthcare provider is the inner ear. In the inner ear, vibrations are received from the eardrum and are sent to the cochlea. The cochlea is a fluid-filled structure that translates vibrations into signals that the brain is able to understand. To test the function of the inner ear, health care professionals would conduct an otoacoustic emissions test (OAE). This test involves inserting a tiny probe in the patient's ear which sends a very soft buzzing noise. In a properly functioning inner ear, the buzzing noise would stimulate the cochlea. When the cochlea is stimulated, the surrounding hair cells will vibrate (American Speech-Language Hearing Association [ASHA], 2015). The vibration of the hair cells emit an almost inaudible sound that travels out of the ear and this tiny sound is what the probe in the OAE test is looking for. When responses from the vibrating hair cells are detected, there is a good chance that the cochlea is functioning normally.

In addition to inner ear tests done through the ear itself, the function of the inner ear can be evaluated through brain activity. Through the use of the auditory brainstem response (ABR) test, the health care provider is able to observe the brainwave activity to sound. This physiologic test is performed through the use of electrodes placed on the infant's forehead, neck, and shoulder. Because of the test's high sensitivity, it is preferred that the infant is asleep. This test is able to diagnose the specific decibel range the infant has impaired (ASHA, 2015).

Hawai'i Newborn Hearing Screening Program

In 1990, universal newborn hearing screening was introduced. At this time, Hawaii Governor Waihe'e signed Act 85 into law. This act required the Hawai'i Department of Health to adhere to four areas: 1) develop methodology for identification and intervention; 2) develop guidelines for screening, identification, diagnosis, and monitoring; 3) develop a plan to involve parents in the medical and educational follow-up and management of the hearing impairment; and 4) develop a plan for the collection of data and program evaluation (Johnson et al., 1997). It wasn't until 1992 when the first hospital in Oahu kicked off the implementation of the newborn hearing screening with the use of OAEs. In 1992, Kapi'olani Medical Center for Women and Children was the first hospital in the state to implement the hearing screening regimen for newborns. Shortly after, Kaiser Medical Center began screening in April 1992, which used unilateral automated auditory brainstem (ABR) screening. The universal newborn hearing screening program was then expanded to Maui Memorial Hospital in February 1993. In July of 1993, the Queen's Medical Center began its hearing screening. Finally, Tripler Army Medical Center implemented screening in the Spring of 1996 (Johnson et al, 1997).

Established by the Hawai'i Department of Health, Hawai'i's newborn hearing program screens babies at one day of age with OAE testing. If the infant is unable to pass the first testing, a follow-up OAE test will be conducted. However, if the infant is unable to pass the second OAE test, an ABR test will be conducted prior to the discharge of the infant. If the infant is not able to pass the ABR test, an outpatient appointment will be scheduled with an audiologist to follow up on the infant's hearing. This follow-up appointment will be scheduled within a month and will determine if the infant has a hearing impairment. Once the infant passes the newborn testing, there aren't any other Hawai'i Department of Health programs to follow-up on the process of

hearing in newborns. Shirley Russ, a writer for the British Medical Journal states, “If we had been able to follow an entire birth cohort prospectively throughout childhood, the number of cases of confirmed hearing impairment would have increases with each passing year. This increase continues at least until the age of nine and probably beyond” (Russ, 2001). Phillip Johnston, a former legislator and chairman for the Board of Directors of Health for America, found similar results to Russ’ research in his experiment and stated, “Deafness was not suspected in 50 percent of these children until some time between 8 months and 48 months of age” (1019). It is extremely important for parents to remember that their child is still vulnerable to any type of hearing loss even after passing the initial screening at birth.

Hawai’i Lions Club

Having over 1.4 million members and 40,000 clubs worldwide, the Lions Club International is considered the world’s largest volunteer service organization (Hawaii Lions District 50, 2010). Part of the international Lions organization, the Hawai’i Lions Club embodies the organization’s slogan of “We serve”. The first local Hawai’i Lions Club was founded in 1926 and was called the “Honolulu Lions Club”. Celebrating 85 years of service throughout the state, the District 50 Hawai’i Lions Club consists of 66 local clubs and has over 1,800 members statewide (Hawaii Lions District 50, 2010). The Hawai’i Lions Club is known to achieve many “firsts” when compared with its international affiliates. For example, the Hawai’i Lions Club welcomed individuals of all races and ethnicities at its first local club, while many other clubs on the mainland adhered to the “all white” clause. The Hawai’i Lions Club was also the first Lions Club in the world to officially induct the first woman member into the club. In 1934, the Kona

Lions Club inducted the very first woman Lion in dedication, which broke the all-male tradition of the Lions Club (Hawaii Lions District 50, 2010).

The Hawai'i Lions Club is known to be actively involved Hawai'i communities in participating in various service events that create positive lasting impacts. One of the organization's signature service events are its vision and hearing screenings. Urged by Helen Keller to become "the knights of the blind" and to make things right for the handicapped, the Hawai'i Lions Club is famed for the free and comprehensive school-based screenings the organization offers. The Hawai'i Lions Club continues its screening initiatives to this day and is considered one of the largest providers of free vision and hearing screening providers to school children. The Hawai'i Lions Club's screening initiative is led by a local audiologist and staffed by dedicated Hawai'i Lions Club members. Both hearing and vision screenings are meant to detect potential eye and ear related concerns. The Hawai'i Lions Club's screening initiatives are all led and staffed by volunteers from the Hawai'i Lions Club and the community. Once at-risk or affected individuals are identified, the Hawai'i Lions Club refers students to receive further reevaluation from a health professional such as a medical doctor or an audiologist.

Methodology

In order to meet this project's expectations, both research-based and participatory-based components were included. The ultimate goal of the project was to spread awareness of the importance in maintaining healthy hearing and to emphasize the vital role school-based hearing screenings play in Hawai'i schools. Starting from the first twenty-four hours of birth, all babies born in Hawai'i hospitals are required by law to receive a hearing test. However, other than physicals checkups done by physicians, there are no other structured opportunities for children to receive a hearing evaluation. In order to address this lack of available screening, this project will be focused on providing free hearing screenings to Hawai'i in the 2015-2016 academic year.

Department of Education students primarily in kindergarten to the third grade were the main population the screening program focused on. By bringing the hearing screening to students in schools, students have increased accessibility to free hearing screenings. Through this, the project aims to eliminate possible barriers that restrict students from receiving a hearing evaluation such as cost, geographical challenges, time availability, and not having access to a primary physician or a health professional that is able to authorize medical referrals. The goal of the hearing screening process itself is to accurately identify individuals with hearing impairments in a timely manner in order for intervention or treatment to begin promptly.

Beginning with a research-based perspective, related literature reviews provided the researcher along with the project a more in depth understanding of the nature of hearing loss. In addition to research, a large portion of this project's goal was to create a significant impact in the screening process of Hawai'i's youth. Hawai'i Lions Club is known for its state and worldwide initiative in preventing, diagnosing, and relieving the burden of hearing impairments.

After drastic budget cuts in spending, the Hawai'i Department of Health dropped its initiative in screening hearing in youth in 1995, ultimately leaving the Hawai'i Lions Club as the largest organization to perform testing for Hawai'i public school students.

The Hawai'i Lions Clubs began its hearing screening initiative in 2007, where its efforts and staff are primarily volunteer-based. The Hawai'i Lions Clubs' hearing screening initiative currently serves about roughly 30% of Hawai'i Department of Education schools. Each participating school is visited once a year where about two or three schools are visited each month of the academic year. Depending on the location of the school, the school-based hearing screenings are usually led by the nearby chapters of the Hawai'i Lions Club. These hearing screenings are solely run by volunteers through the Hawai'i Lions clubs and are overseen by an audiologist. Screeners involved in the hearing screening process are trained annually by the audiologist to ensure competency in screening procedures. The focus of the screening program targets students in kindergarten to the third grade, as students in this age bracket tend to have the highest benefit when receiving early intervention and treatment in reducing the negative effects associated with hearing loss. However, students from pre-kindergarten to twelfth grade have been screened in 2015-2016 academic year. The hearing screenings usually take place in the school's library, or any other location that provides an ample amount of space and a very quiet environment. The hearing screenings conducted by the Hawai'i Lions Club are optional, where students are required to submit an acknowledgment form signed by their parent or guardian in order to participate in the screening process. At the end of the screening process, parents of the students participating in the screening process are notified of their child's results. Each student is given either the status of "pass" or "refer" where referred students will be recommended to visit their primary care physician or an audiologist for a follow-up evaluation and possible treatment.

The Hawai'i Lions Club's hearing screening program utilizes four types of testing: otoscopic evaluation, tympanogram testing, pure-tone testing, and otoacoustic emissions testing (OAE). Students typically begin the screening process with otoscopic evaluation to examine earwax levels and the appearance of the student's eardrum, move onward to the tympanogram testing, then the student finished the screening process with the pure-tone testing which involves frequencies 2k, 3k, and 4k both at 25 decibels. In order for the a student to pass the tympanogram testing, the student must have a Type A reading which represents the maximum peak compliance obtained from the movement of the eardrum, which is expected in an individual with normal hearing. For the student to pass the otoscopic evaluation, the screener should notice an intact tympanic membrane with no perforations or holes. In addition, the surrounding area of the membrane should have a shiny "pearly white" appearance. For a student to pass the pure-tone testing, the student must be able to indicate having heard all 2k, 3k, and 4k beeping sounds at 25 decibels.

The Hawai'i Lions Club's hearing screening program utilizes three types of referrals: audiological referral, medical referral, and a combination of audiological and medical referrals. An audiological referral is given to students who need a comprehensive audiological examination as follow-up. Typically a student is given an audiological referral if the individual either failed one of the three frequencies in pure-tone testing and failed the OAE examination or fail two out of the three frequencies in pure-tone testing. A medical referral is usually given to a student that is associated with foreign objects in ear, bleeding, perforation of the tympanic membrane, ear infection behind the eardrum, or fluid being present behind the eardrum. In terms of testing, a medical referral is usually given if a student fails the otoscopic evaluation, tympanogram evaluation, or if an excess amount of earwax or fluid is found in the ear. Cases

where both an audiological and medical referral is needed would entail a combination of concern in the student's middle ear and his/her ability in responding to all three frequencies during pure-tone testing.

The project included active involvement with school-based hearing screenings completed in Oahu schools. The project's participation ranged from all stations of the screening process to data management duties. Once each screening was completed, total referral number was aggregated to report to the school, the Hawai'i Department of Health, as well as filed into the Hawai'i Lions club's database. Descriptive statistics was produced using data collected throughout the 2015-2016 academic year.

Data obtained from present-day screenings with the Hawai'i Lions Club and previous data from the Hawai'i Department of Health was compared. More specifically, the data from the very last year of the Hawai'i Department of Health's hearing intervention in Hawai'i schools was used as a benchmark comparison in looking at the amount of students reached and the overall capacity of the volunteer-based Hawai'i Lions Clubs hearing screening program. The comparison allowed for a general trend to be made in regards to the findings from the 2015-2016 Lions Club findings to the 1995 Hawai'i Department of Health data. The results of this comparison provided recommendations to how the Hawai'i Lions should continue running its hearing screening programs in terms of expansion and program management.

Results

During the 2015-2016 academic year, 35 Hawai'i public schools participated in the screening process. Participating students ranged from students in prekindergarten to the twelfth grade, but primarily consisted of students in kindergarten to third grade. Participating schools were located throughout Oahu, Maui, and Hawai'i Island (Hilo and Kona). A total of 5,937 students were screened in the 2016 academic year. The number of referred students was 233, while 5,704 students passed the hearing screening. The prevalence of a student being referred from the screening was calculated to be 3.9% as can be seen in Table 1.

In order to be referred from the screening, the student must be eligible for one or more of the three criteria to be referred: audiological referral, medical referral, or both. An audiological referral consists of a referral in either: a failure in one of three pure tone frequencies and a fail in OAE testing or a failure in two or more pure tone frequencies. 102 students (44% of referred students) were referred due to audiological-related issues. Those receiving an audiology referral were recommended to consult an audiologist for a complete hearing assessment. On the other hand, a medical referral can be due to the following conditions: bleeding in the ears, perforated eardrum, otorrhea, or type B (flat tympanograms). 55 students (24% of referred students) were referred due to medically-related conditions. Students receiving a medical referral were recommended to consult their designated primary care physician for assessment and possible treatment. Students receiving both an audiological and medical referral were due to a combination of the conditions listed above or an excess of earwax. 76 students (32% of referred students) were referred due to medically and audiology-related conditions. Students receiving both a medical and audiology referral were recommended to consult their designated primary care physician as well with an audiologist.

Grade	Number Screened	Referred
PK	4	0
K	1397	52
1	1972	86
2	2145	75
3	276	8
4	65	4
5	50	5
6	14	1
7-12	17	2
Total: 5,937		Total: 233

Table 1: Displayed is the number of all student screened in the 2015-2016 Hawai'i Lions Club school-based hearing screening program. Along with the number screened, grade level and number referred are included.

In addition to looking at the aggregate pass and refer rates, the project dichotomized the data collected in Oahu in regards to geographical location. This analysis was only done for schools located in Oahu as the number of participating schools in the neighbor islands is limited. Schools were categorized into their general location on the island: north, south, east, west and windward. Five schools located on the north side of the island participated in the Lions' hearing screening with a total of 306 students. Out of the 306 screened, ten students had referred, which equates to a prevalence of 3.2% in regards to referrals. Ten schools located on the south side of the island participated in the Lions' hearing screening with a total of 1,148 students. Out of the 1,148 screened, 110 students had referred, which equates to a prevalence of 9.6% in regards to

referrals. One school located on the east side of the island participated in the Lions' hearing screening with a total of 183 students. Out of the 183 screened, one student referred, which equates to a prevalence of .5%. Eleven schools located on the west side of the island participated in the Lions' hearing screening with a total of 1,258 students. Out of the 1,258 screened, thirty students had referred, which equates to a prevalence of 2.4%. Finally, two schools located on the windward side of the island participated in the Lions screening with a total of 98 students. Out of the 98 screened, six students had referred, which equates to a prevalence of 6.1%.

In addition to data analysis and interpretation of data collected in the 2015-2016 academic year, a comparison was made with data previously taken from the Hawai'i Department of Health (DOH). The dataset used to compare is from the last year of the Department of Health's school-based hearing screenings before the termination of the program. Although the two hearing screening programs differ in equipment used, protocols implemented and referral criteria, general trends such as prevalence proportions and percentages. The DOH screening conducted in the 1994-1995 academic year screened 72,896 students. Participating students ranged from pre-kindergarten to twelfth grade and resided in cities within Oahu, Kauai, Maui, and Hawai'i Island. The DOH screening utilized the same three types of tests: pure-tone, tympanogram, and otoscopic. However, unlike the Hawai'i Lions Club's screenings, the Department of Health did not use Otoacoustic Emissions (OAE) testings for students who fail any of the three main tests used. Out of the 72,896 screened, 4,259 students were referred for further evaluation. The prevalence of students being referred from the screening process was calculated to be 5.8%. Health professionals that ranged from audiology-related and non-audiology related diagnoses diagnosed the referred students. The most common diagnoses include otitis media (41% of referrals), excess of wax or blockage from a foreign object (16% of

referrals), and sensorineural loss (5% of referrals). The use of this pre-existing dataset allowed for a comparison to be done in regards to screening efficiency, program capacity and overall impact.

Grades	Number Screened	Number Referred	% Total Referred	Completed Referrals	% Completed Referrals	# With Deficit	% With Deficit
Pre-K	16,618	835	5.14%	574	98.74%	438	76.31%
K	15,751	824	5.21%	631	76.58%	517	81.93%
1	15,385	799	5.04%	565	70.71%	451	79.82%
2	14,991	634	4.01%	453	71.45%	358	79.03%
3	2,528	321	11.23%	208	64.80%	167	80.29%
4	2,047	225	8.21%	143	63.56%	108	75.52%
5	1,681	160	7.26%	97	60.63%	70	72.16%
6	1,286	165	9.72%	90	54.55%	68	74.44%
7-12	1,124	159	47.29%	72	45%	65	90.27%
Special Education Students	1,484	4,259	8.69%	91	66.42%	78	85.71%
Totals:	72,896	4,259	5.47%	2,924	68.65%	2,319	79.31%

Table 2: Displayed is the number of all students screened in the 1994-1995 Hawai'i Department of Health school-based hearing screening program. Along with the number screened, grade level, number of referred, number of completed referrals, number of facilities along with each respective percentages are displayed.

Similar to the Hawai'i Lions Club data, the Hawai'i Department of Health screening data was dichotomized in regards to the geographical of participating Oahu schools. 13,148 students

were screened on the windward side of the island. Out of the number screened, 610 students (4.64%) have referred. On the leeward side of the island, 13,877 students were screened. Out of those screened, 883 students (6.36%) have referred. In Honolulu, 13,769 students were screened with 514 (3.76%) students referred. Lastly, 13,755 students in central Oahu were screened. Out of the students screened, 701 students (5.10%) were referred.

The 1994-1995 Hawai'i Department of Health study was able to follow-up with those referred, and noted the number of those who followed through the referral process. Out of the 4,259 students referred in the screening process, 2,924 (68.65%) were able to follow-up with a physician or audiologist for further evaluation. Out of those individuals who followed-up for further evaluation, 2,319 students (7.31%) were found to have some type of hearing loss, 1,258 students (54.25%) were diagnosed with ear infections, 521 students (22.47%) had excess earwax or the presence of foreign objects in the ear canal, and 145 students (6.25%) had sensorineural hearing loss. Treatment given to the referred included: 1,215 (66.21%) were given medication, 452 (24.63%) had excess earwax or foreign material extracted from the ear, 153 (8.34%) received surgery, and 21 (1.14%) were given hearing aids.

Conclusion

The project's findings recommends for the Hawai'i Lions Club to continue the operation of its screening, and to look into expansion of working with more schools. With the Hawai'i Lions Club's hearing screening initiative being the largest provider in offering free school-based hearing screenings in Hawai'i public schools, the study recommends to promote an increase in public awareness to foster support from the public and state agencies. Through the project's component of long-term active service learning into the Hawai'i Lions Club's screening initiative, the spirit of volunteerism and goodwill was found to be of the utmost importance in the survival of the screening program. To ensure the proper management and efficiency of current hearing screenings in already-established schools, more volunteers need to be recruited and trained to conduct these school-based hearing screenings. Being purely run by the Hawai'i Lions Club's volunteers, costs such as equipment staffing are fully fronted by the service-oriented organization.

The use of previously-collected data by the Hawai'i Department of Health in 1995 served as a model that allows for comparison in efficacy and impact between the two programs. Although comparing the DOH's federally funded program with the Hawai'i Lions Club's volunteer-run program has its caveats, this comparison makes emphasizes the importance of the Hawai'i Lions Club's initiative and highlights areas of improvement relevant to the Hawai'i Lions' hearing program. For example, when comparing the Hawai'i Lions Club's impact of screening 5,937 students with the 72,896 students screened by DOH in 1995, it is evident that there are students and school that are not participating in the Lions' hearing screening initiative. With about 180,409 students enrolled in Hawai'i public schools in 2015-2016 (DOE, 2015), the Hawai'i Lions Club reached out to 3.3% of enrolled students (5,937 total screened). Although

the capacity of the Hawai'i Lions Club's program is not equivalent to that of a federally funded program, an initiative to screen more students and schools is vital. The project recommends the Hawai'i Lions Club to set a goal of reaching at least 40% of Hawai'i Department of Education schools as the club currently reaches out less than 30% of schools.

The study found that the two school-based hearing screenings reported very similar referral rates. With the Hawai'i Department of Health's 1994-1995 screening having a referral prevalence proportion of 5.8 and the Hawai'i Lions Club's 2015-2016 hearing screening having a referral prevalence of 3.9, the findings are quite similar. Despite the population differences between the two programs, the referral rates were surprisingly similar. This similarity can be seen as an indication of accuracy between the two screening programs. What differed between the two programs is the referral rates according to geographical locations in Oahu. For example, the Hawai'i Lions Club found Honolulu and the windward side of the island to have the highest prevalence of referrals, while the Department of Health study found leeward and central Oahu having the most referrals. Though it is important to account for the differences in study population, other factors in this difference can be attributed to this. For example, this could be attributed to a change in the area's number of public school students or factors related to socioeconomics.

The project recommends for the Hawai'i Lions Club to consider following-up on participants in terms of completed referrals and final diagnosis. By taking a more active approach in what happens after the school-based hearing screening, more students would hopefully complete the referral given by the Hawai'i Lions Club. Knowing of participant's final diagnosis will allow the Hawai'i Lions Club to strengthen and improve their screening system in accurately referring students. For example, obtaining the medical history of a participant may

increase the likelihood of volunteers recognizing a potential hearing loss in the student. An example of medical information the Hawai'i Lions Club could look into requesting is the newborn hearing screening results of the participant. The newborn hearing screening results could be collected along with the permission form and would allow the Hawai'i Lions Club to compare results from the newborn hearing examination to the school-based hearing screening, which will possibly give a clearer picture to the screeners when evaluating students' hearing abilities. In addition, by adding newborn hearing screening results to the data collection criteria, the Hawai'i Lions Club has the ability to evaluate the prevalence of a student getting a referral in the school-based screening depending if the individual had either passed or failed the newborn hearing screening. If chosen to do so, the Hawai'i Lions Club would be one of few who have been able to do so.

Being the largest provider of school-based hearing screenings to Hawai'i Department of Education schools, the Hawai'i Lions Club has been leading this volunteer initiative for nearly ten years. Recognizing the need of school-based hearing screenings, the Lions Club continues to "fill the shoes" from the Hawai'i Department of Health's initiative. By providing free school-based hearing screenings to Hawai'i schools, students who previously did not have access to hearing screenings can now be screened. By safeguarding the hearing health of Hawai'i's school children, the Hawai'i Lions Clubs promotes the development of healthy, academically achieving, and confident youth. The Hawai'i Lions Club serves in the frontline of diagnosing delayed onset of hearing loss in school-aged children and preventing the detrimental effects related to hearing loss.

Through the use of the project's recommendations such as the continuation of screening, use of past medical history, and expanding to more Hawai'i Department of Education schools. The Hawai'i Lions Club hearing screening initiative may consider advocating for a policy change in support for school-based hearing screenings. If the Hawai'i Department of Health were to have interest and capacity to have part in the Hawai'i Lions Club's school-based hearing screening initiative, many weaknesses found from this project would potentially be dissolved. For example, the involvement of Hawai'i Department of Health into the screening process would hopefully entail implementing the program into all Hawai'i Department of education schools similar to the 1994-1995 hearing screening program the study focused on.

Through a partnership with the Hawai'i Department of Health, the Hawai'i Lions Club's hearing initiative will have increased access to additional resources such as health professionals and screening protocols. With a collaboration of Hawai'i state audiologists, the Hawai'i Lions Club will potentially have a larger impact in identifying hearing impaired individuals and a higher success rate in encouraging referred participants to follow up for further evaluation from their designated health professional.

If the Hawai'i Department of Health were to be involved once again with school-based hearing screenings, there is a stronger possibility for the Hawai'i Lions Club to have the opportunity to gain access to participants' medical history. This medical history could be used to create a linkage between the likelihood of passing the universal newborn hearing screening, yet being diagnosed with mild to moderate or sensorineural hearing loss in a school-based hearing screening. Another interesting linkage that could be made from this collaboration is the association between the students' hearing health and academic performance displayed in the

classroom. This would allow the study to collaborate with the participant's teachers and possibly standard test scores in search for an association between hearing and academic success.

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